Soil Sequences of Western Samoa[1]

C. L. SCHROTH[2]

THE TWO IMPORTANT regional genetic factors governing the formation of the soils of the volcanic high islands of the Pacific are the age of the parent rock and the amount and distribution of rainfall. The islands of Upolu and Savai'i in Western Samoa offer an excellent opportunity to study the effects of these two factors upon soil development. The islands experience wide ranges of orographic rainfall and have parent rocks of different ages.

The purpose of this study was to sample several soil series in a way that provided sequences of soils formed on parent rock of different ages and subjected to a similar rainfall gradation within each sequence. Sampling of soils in this manner allowed separation of the effects of rainfall, age of parent rock, and the interaction of these two factors on soil formation.

DESCRIPTION OF THE STUDY AREA

Landform

Western Samoa lies between the latitudes 13° and 15° S and longitudes 169° and 173° W. It includes the two major islands of Upolu and Savai'i and two smaller islands, Apolima and Manono. Savai'i has an area of 2,027 km^2, a length of 78 km, a maximum width of 45 km, and a maximum elevation of 1,830 m. Upolu has an area of 1,194 km^2, a length of 78 km, a maximum width of 27 km, and a maximum elevation of 1,200 m.

Savai'i and Upolu have four topographic regions. The lowland region contains undulating and gently rolling terrain with slopes of 3 to 9 percent, and extends from sea level to 225 m. The second region, the foothills, contains rolling and strongly sloping land with slopes ranging from 9 to 27 percent. The third region, the uplands, is a plateau which occurs at 600 m on Upolu and eastern Savai'i and at 1,200 m in central Savai'i. The upland region has undulating to rolling relief and contains numerous extinct cinder cones. The fourth region or highlands, found only on Savai'i, contains clusters of cinder cones in the center of the upland plateau.

Age

Five distinct periods of volcanic activity (Kerr and Wood, 1959; Stearns, 1944) shaped Western Samoa. Initial activity of the Fagaloa volcanics produced two broad elongated shield-shaped basaltic domes during the late Tertiary period. Intense weathering of the Fagaloa volcanics during the early to middle Pleistocene produced a deep reddish soil with a solum varying in thickness from 3 to 5 feet. Large amphitheatre-headed valleys with steep slopes and sharp ridges characterize the Fagaloa volcanics.

After this erosional period lava flows from the Salani volcanics increased the height of Upolu to 900 m and Savai'i to 1,200 m. The Salani volcanics are much less weathered and eroded than the Fagaloa volcanics. Soil varying in depth from 30 to 60 cm covers the Salani weathered rocks. Throughout the last glacial period extensive Mulifanua volcanics erupted. These lavas are weathered to a moderate degree and are relatively uneroded. Large boulders on the surface are common and the depth of solum is usually 30 cm or less.

Puapua and Aopo volcanics erupted during the Post-Flandrian Thermal Maximum and continued until 1911 (Kerr and Wood, 1959). Soils occurring on these volcanics are Lithosols that range from a thick partially decomposed layer of organic material to a thin cover of weathered rock.

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[2] Present address: Box 1711, Juneau, Alaska 99801.

Climate

Direction of the prevailing winds and island elevation govern the climatic pattern of Western Samoa. The prevailing winds flow parallel to the central ridges (southeast to northwest) of Upolu and Savai'i producing a concentric climatic pattern around each island. The western lowlands of Savai'i and Upolu occur in a rainshadow. These areas usually experience dry periods of 1 to 3 months with less than 75 mm of rainfall per month. As elevation increases, rainfall increases from 2,750 mm mean annual rainfall (MAR) at the coast to more than 6,350 mm MAR in the highlands of Savai'i (Wright, 1963). Because the islands are below the inversion layer, there are no abrupt changes in the rainfall pattern with increasing elevation.

The temperature of Western Samoa is isothermal. The mean annual temperature at the coast of both islands is 25.5° C and decreases to 20.5° C in the uplands of Upolu and to 17.8° C in the highlands of Savai'i. Temperature decreases with increasing elevation at a rate of 0.65° C/100 m (Curry, 1955).

MATERIALS AND METHODS

The soils represented in this study, collected from three sequences differing in age, had a similar sequence of climatic zones. Wright's classification of Western Samoa soils (Wright, 1963) provided a guide for the selection of the soils. The genetic factors for the soil series samples and the locations of the sampling sites are given in Table 1 and Fig. 1, respectively.

Subsamples from the profile samples were air-dried and gently crushed to pass a 10-mesh screen. One quarter of each subsample was ground to pass a 100-mesh screen for organic carbon, total nitrogen, and free iron oxide determinations.

Total nitrogen was determined by the Kjeldhal method and organic carbon by the Walkley-Black method (Walkley and Black, 1934) with use of a recovery factor of 77 percent. Cation exchange capacity (CEC) was determined by NH_4^+ saturation and direct distillation of NH_3. Exchangeable calcium, magnesium, and potassium were displaced by neutral ammonium acetate. Exchangeable calcium and magnesium were determined on a Perkin Elmer atomic adsorption unit and exchangeable potassium on a Beckman DU flame spectrophotometer. Soil pH was determined in a suspension of 1:5 soil-water ratio, and in a suspension of 1:5 soil-N KCl ratio. Free iron oxides were determined by the method described by Kilmer (1960). Sample size was reduced to 0.5 g to prevent exhaustion of the dithionite before extraction of all the free iron oxides. Mineralogical analysis was performed on preferentially oriented potassium-saturated clays with a Philips Norelco X-ray diffractometer using the Kα radiation of copper and a nickel filter.

TABLE 1

GENETIC FACTORS

SEQUENCE	SOIL SERIES	RAINFALL (mm)	TEMPERATURE (° C)	NO. DRY MONTHS	VOLCANICS
	Sataua	2,750	25.5	3	Mulifanua lava
	Saleimoa	3,000	25.5	1–2	Mulifanua lava
Lefaga	Lefaga	3,250	23.9	0–1	Mulifanua lava
	Mauga	4,000	22.2	none	Mulifanua lava
	Salega	4,350	20.5	none	Mulifanua ash
	Falealili	3,250	25.5	none	Salani lava
	Fagaga	4,000	23.3–25.5	none	Salani lava
Falealili	Solosolo	3,750	22.2	none	Salani lava
	Etimuli	4,375	22.2	none	Salani lava
	Afiamalu	5,000	20.5	none	Salani ash
	Vaipouli	3,000	25.5	0–1	Fagaloa lava
Papaloa	Sauaga	3,250	25.5	none	Fagaloa lava
	Upolu	4,000	22.2	none	Fagaloa lava

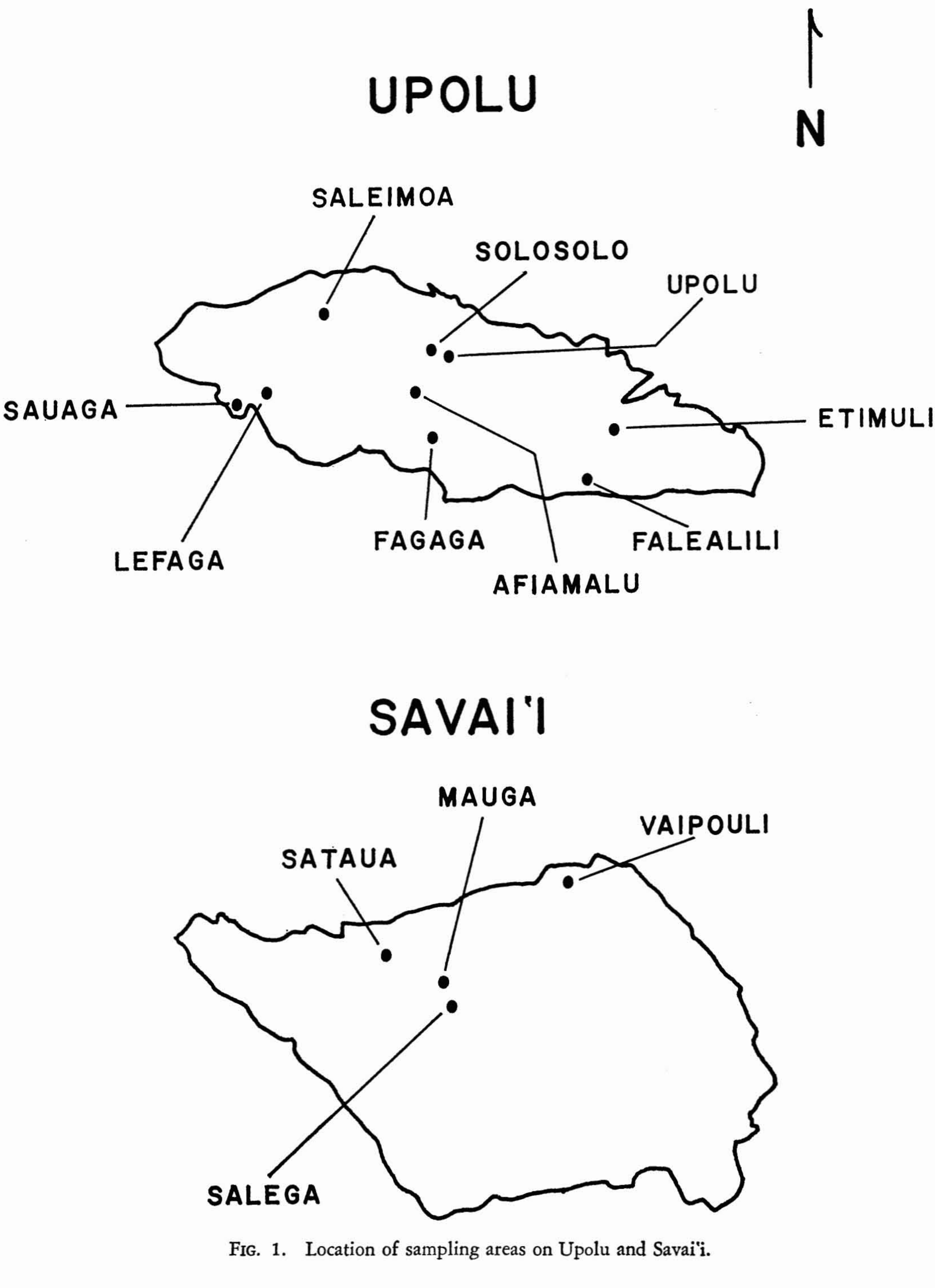

FIG. 1. Location of sampling areas on Upolu and Savai'i.

RESULTS

Lefaga Sequence

The results of the chemical and mineralogical analyses are presented in Tables 2 and 3, respectively. The youngest soil series in this study —Sataua, Saleimoa, Lefaga, Mauga, and Salega —are included in the Lefaga sequence. These soils, with the exception of those in the Salega series, are formed in residuum of the lavas belonging to the Mulifanua volcanics. The Salega series is developed in residuum of ash and scoria of the same age.

The Sataua series occurs in the lowlands of western Savai'i and the Saleimoa and Lefaga series occur in the northwestern and southwestern lowlands of Upolu. These soils occur under the lowest rainfall of 2,750 mm to 3,250 mm MAR and experience pronounced dry periods. The soils are extremely bouldery and are relatively unweathered. The profile of the Sataua series consists of a black (10 YR 2/1) mollic epipedon and a bouldery dark gray brown (10 YR 3/2) cambic subsurface diagnostic horizon. The **soil** is friable with a strong, fine-to-medium granular structure in the epipedon and a weak-to-medium subangular blocky structure in the subsoil. The Sataua series generally has a high content of organic carbon, total nitrogen, and exchangeable bases (Table 2). The soil pH is slightly acid and the base saturation is high in the epipedon but decreases abruptly in the subsoil.

The Saleimoa and Lefaga series are similar to the Sataua series except the base saturation is lower and the soil solums are deeper in the Saleimoa and Lefaga series. The Saleimoa series has a mollic epipedon and the Lefaga series has an umbric epipedon.

The Sataua, Saleimoa, and Lefaga series consist of X-ray amorphous materials along with small amounts of mixed-layer clay minerals. The Sataua series is classified as Lithic Dystropepts (Soil Survey Staff, 1960; 1968), and the Saleimoa and Lefaga series are classified as Typic Dystropepts.

The Mauga series is located in the foothills of Savai'i where the rainfall is approximately 4,000 mm, the solum is bouldery (average diameter—20 cm) and occasionally reaches a depth of 60 cm. The umbric epipedon is very dark brown (7.5 YR 2/2), has a strong, medium granular structure, and is friable. The subsoil is dark brown (10 YR 3/3), has a weak, coarse blocky structure, and is very friable. The organic carbon content is very high in both the epipedon and the subsoil. Due to continuous leaching of the profile, the base saturation is extremely low. Mineralogically the soil consists of X-ray amorphous materials with a trace of gibbsite. The Mauga series is classified as Histic Humitropepts.

The Salega series is located in the uplands of Savai'i where it is developed from ash and scoria and occurs under a rainfall of 4,375 mm. The umbric epipedon is very dusky red (2.5 YR 2/2), has a texture of peaty loam and a strong, fine granular structure. The subsoil is dark brown (7.5 YR 3/2), has a fine-to-medium subangular blocky structure, and is smeary. The soil is thixotropic, consists of X-ray amorphous materials with traces of gibbsite, and dehydrates irreversibly upon drying. Organic carbon and total nitrogen are very high, and the base saturation in the subsoil is almost zero. The Salega series is classified as Typic Hydrandepts.

Falealili Sequence

The soils of the Falealili sequence—Fagaga, Falealili, Solosolo, Etimuli, and Afiamalu—are, with the exception of those in the Afiamalu series, formed in residuum of the Salani lavas. The Afiamalu series is developed in residuum of ash and scoria of the same age.

These soils originally separated on a climatic zone basis may be placed into two subgroups: Oxic Dystropepts and Oxic Humitropepts. All the soils are highly weathered and are predominately oxidic in nature. The Falealili and Fagaga series are in the lowlands and foothills of Upolu, respectively. The depth of solum is generally 50 to 60 cm. The umbric epipedon is very dark brown (10 YR 2/2) to dark brown (10 YR 3/3), has a weak-to-moderate, fine-to-granular structure, and is friable. The cambic subsurface diagnostic horizon is dark brown (10 YR 3/3), has a moderate, medium-to-coarse medium subangular blocky structure, and contains many cobbles. These two series have moderate amounts of organic carbon, total nitrogen, and free iron oxides. The pH is acid and the content of exchangeable bases is low. Percent base saturation ranges from 46 to 28 in the epipedon and 22 to 8 in the subsoil. The mineralogy of these soils is gibbsitic.

The Solosolo and Etimuli series, which are classified as Oxic Humitropepts, occur in the foothills of Upolu. The depth of solum is 70 to 80 cm. The umbric epipedon is dark brown (10 YR 3/3) and has a weak, medium-to-coarse granular or moderate, medium subangular blocky structure. The subsoil is dark brown (10 YR 3/3), has a moderate, medium-to-coarse subangular blocky structure, and has a few cobbles in the profile. These series have moderate amounts of organic carbon and total nitrogen, a very low content of exchangeable bases, an acid pH, and very high amounts of free iron oxides. Mineralogically, these soils are gibbsitic.

The Afiamalu series, developed in ash, under the intense weathering environment of 5,000 mm MAR and 20.5° C MAT, is a highly weathered soil. The umbric epipedon is dark brown (10 YR 4/3) and has a moderate, medium granular structure. The subsoil is dark brown (7.5 YR 4/4), has a strong, coarse, subangular, blocky structure, and has few cobbles. Depth of solum exceeds 100 cm. This series, essentially depleted of exchangeable bases, is very acid, and has large quantities of gibbsite and iron and titanium oxides. In the Afiamalu profile, gibbsite decreases and halloysite increases with increasing depth. The Afiamalu series is classified as Oxic Humitropepts.

Papaloa Sequence

The soils of the Papaloa sequence—Vaipouli, Sauaga, and Upolu—are developed in residuum of the Fagaloa volcanics. These series are not separated on the basis of climate, like those of the Lefaga and Falealili sequences, but are separated on the basis of landform.

The Vaipouli series occurs on a level bench near the coast of Savai'i. The depth of solum varies from 100 to 150 cm. The ochric epipedon is brown (7.5 YR 4/4), has a strong, fine to medium subangular blocky structure, and is acid in reaction. The oxic subsurface diagnostic horizon is reddish brown (5 YR 4/4), and has a massive-to-moderate blocky structure. Only traces of exchangeable bases are present in the subsoil. Base saturation is very low and the free iron oxide content is very high. The profile is free of stones, lacks weatherable minerals, and is essentially gibbsitic. The Vaipouli series is classified as Typic Umbriorthox.

The Sauaga series occurs on the steep unstable slopes of the Fagaloa volcanics in southwest Upolu. The solum is shallow and ranges in depth from 30 to 45 cm. The umbric epipedon is dark reddish brown (5 YR 3/3), has a strong, medium, subangular blocky structure, and is acid. The cambic subsurface diagnostic horizon is reddish brown (5 YR 4/4), has a few thin clay skins, and overlies soft weathered basaltic andesite. The mineralogy is halloysite with traces of gibbsite. Due to the shallow profiles, the Sauaga series are Lithic Oxic Dystropepts.

The Upolu series occurs on unstable benches of the Fagaloa volcanics near the north central coast of Upolu. The depth of solum varies from 60 to 80 cm. The umbric epipedon and subsoil are dark brown (10 YR 3/3). The epipedon has a weak, fine-to-medium granular structure and the subsoil (possible argillic horizon) has a strong, fine-to-medium subangular blocky structure with many continuous clay skins. The soil is slightly acid, has moderate amounts of exchangeable bases and free iron oxides, and has a base saturation of 38 percent in the epipedon and 13 percent in the subsoil. The soil contains halloysite and gibbsite clay minerals. The Upolu series is tentatively classified as Humoxic Tropohumults.

DISCUSSION

Effects of Age of Parent Rock and Rainfall

The properties of the soils belonging to the Lefaga and Falealili sequence best illustrate the influences of age of parent rock and rainfall. The Sataua, Saleimoa, and Lefaga series, which occur on the youngest parent rock in the lowest rainfall areas experiencing several dry months, show the least profile development. These soils have solums generally less than 60 cm, contain considerable quantities of unweathered cobbles and boulders, have significant amounts of exchangeable bases, and essentially consist of X-ray amorphous materials with small amounts of mixed-layer silicates (Table 3).

These are young soils which have not been

TABLE 2

CHEMICAL ANALYSES OF SELECTED WESTERN SAMOA SOILS

	DEPTH (cm)	pH (H_2O)	pH (KCl)	ΔpH	CEC*	Ca*	Mg*	K*	% BASE SAT.	% Fe_2O_3	% ORGANIC CARBON	% TOTAL NITROGEN
Sataua	0–15	6.0	5.5	−0.5	56.1	33.5	8.6	1.28	78	3.4	17.3	1.66
	15–30	5.9	5.2	−0.7	28.7	7.8	2.0	0.16	36	4.5	4.5	0.75
Saleimoa	0–10	6.4	5.9	−0.5	73.5	40.1	11.3	0.50	71	7.0	16.9	1.41
	10–30	6.3	5.7	−0.6	54.3	21.8	5.4	0.24	51	8.8	11.1	0.98
	30–60	6.3	5.8	−0.5	40.4	5.4	2.2	0.05	19	9.2	6.5	0.55
Lefaga	0–5	5.7	5.1	−0.6	64.4	25.4	10.6	0.55	57	7.2	17.9	1.75
	5–45	5.9	5.4	−0.5	27.0	3.7	2.8	0.12	25	10.6	4.9	0.66
Mauga	0–30	5.7	5.1	−0.6	85.5	11.9	5.1	0.43	21	10.1	20.7	1.61
	30–60	6.1	5.5	−0.6	62.0	5.8	3.2	0.11	15	13.0	13.5	1.02
Salega	0–23	5.0	4.6	−0.4	78.9	1.2	1.1	0.45	4	5.6	18.4	1.24
	23–40	5.5	5.1	−0.4	67.1	tr**	0.3	0.06	0	4.9	12.2	0.88
Falealili	0–15	5.7	4.9	−0.8	31.2	7.3	6.0	0.38	46	9.7	7.8	0.69
	15–50	5.7	5.2	−0.5	16.2	2.3	1.0	2.04	22	13.9	2.3	0.21
Fagaga	0–8	5.6	5.0	−0.6	43.3	7.3	4.4	0.32	28	13.7	9.9	0.70
	25–60	5.7	5.3	−0.4	23.8	0.9	0.7	0.09	8	17.5	4.4	0.24
Solosolo	0–30	5.6	5.1	−0.5	26.9	3.2	1.8	0.12	19	17.9	6.1	0.46
	30–50	5.9	6.0	0.1	12.7	tr	0.1	0.02	1	19.9	2.1	0.10
	61–71	5.9	6.0	0.1	11.4	tr	0.1	0.02	1	19.4	1.6	0.06
Etimuli	0–23	5.0	4.8	−0.2	24.5	0.9	0.8	0.17	8	20.9	5.0	0.40
	23–51	5.1	5.4	0.3	15.3	tr	0.1	0.07	2	22.5	1.2	0.10
	56–71	5.4	5.7	0.3	12.3	0.2	0.3	0.07	6	22.5	0.7	0.05
Afiamalu	0–10	5.1	4.5	−0.6	26.0	0.6	0.7	0.28	7	24.7	8.4	0.54
	10–35	5.3	4.6	−0.7	21.6	0.1	0.2	0.12	3	15.6	6.5	0.38
	35–60	5.7	6.0	0.3	6.5	—	0.1	—	2	29.6	0.9	0.06
	60–99	5.5	6.1	0.6	4.7	—	0.1	0.02	5	31.4	0.6	0.03

TABLE 2 (*continued*)

	DEPTH (cm)	pH (H_2O)	pH (KCl)	ΔpH	CEC*	Ca*	Mg*	K*	% BASE SAT.	% Fe_2O_3	% ORGANIC CARBON	% TOTAL NITROGEN
Vaipouli	0–20	5.9	5.5	−0.4	21.4	5.1	3.0	0.14	39	19.4	5.8	0.45
	20–53	5.8	5.6	−0.2	11.4	tr	0.4	0.01	4	21.7	2.5	0.15
	53–79	5.6	5.7	0.1	11.2	tr	0.1	0.03	2	21.8	1.9	0.13
	79–104	5.9	6.3	0.4	5.8	tr	0.0	—	1	25.8	0.2	0.02
Sauaga	0–15	5.3	4.7	−0.6	24.6	4.7	5.1	0.34	42	13.4	4.0	0.37
	15–30	5.2	4.5	−0.7	13.2	1.4	2.7	0.02	33	14.3	0.6	0.08
Upolu	0–10	5.6	5.4	−0.2	39.4	10.6	3.8	0.42	38	17.3	6.6	0.55
	10–30	6.0	5.8	−0.2	29.6	7.0	1.6	0.08	30	19.4	2.6	0.21
	30–60	6.5	6.4	−0.1	16.8	1.7	0.3	0.08	13	21.9	0.4	0.08

* Meq/100 g.
** Trace.

TABLE 3

SUMMARY OF THE MINERALOGICAL ANALYSES

SEQUENCE	SOIL SERIES	MIXED LAYER	AMORPHOUS	GIBBSITE	KAOLIN
	Sataua	x	xx		
	Saleimoa	xx	xx		x
Lefaga	Lefaga	x	xx	x	
	Mauga		xxx	x	
	Salega		xxxx	x	
	Falealili			xxx	
	Fagaga			xxx	
Falealili	Solosolo			xxxx	
	Etimuli			xxxx	
	Afiamalu			xxxx	xxx
	Vaipouli			xxxx	
Papaloa	Sauaga			x	xxx
	Upolu			xx	xx

NOTE: x, trace amounts; xx, small amounts; xxx, moderate amounts; xxxx, large amounts.

subjected to the weathering environment for sufficient time to permit thorough desilication and base removal. With dry periods ranging from 1 to 3 months, insufficient leaching subsequently enhances base accumulation. The high base content, particularly magnesium, is conducive to 2:1 layer silicate development (Uehara and Sherman, 1956).

Another factor which possibly influences the amount of exchangeable bases is organic matter. There appears to be a good correlation between organic carbon and base content in the Sataua and Saleimoa series (Table 2). The reason for this correlation is the significant relationship between organic carbon and CEC ($r = 0.888$) and between total nitrogen and CEC ($r = 0.905$). The intercept of the regression which relates CEC to organic matter indicates that the average CEC of the mineral fraction of Western Samoa soils (based on 52 profiles) is 10 meq/100 g. The organic fraction, therefore, is the prime contributor to the soil's ability to retain bases.

In the high rainfall areas of the Lefaga sequence, the organic matter has a diminished effect on base retention because rainfall and continuous leaching are the overriding factors. With increasing rainfall within the Lefaga sequence, the base saturation decreases to almost zero, pH ranges from slightly acid to acid, free iron oxides increase, the depth of solum increases, and the percent organic carbon and the percent total nitrogen unexpectedly remain relatively constant.

The mineralogy of the Mauga and Salega soils is X-ray amorphous materials with trace amounts of gibbsite. In these soils weathering and leaching proceed at a rapid rate. Under these conditions hydrous oxides of aluminum and iron accumulate.

In the Falealili sequence the rainfall effect is again obvious, but age amplifies this effect. The soils in this sequence, subjected to the weathering environment for the longer period of time, have become more weathered than the comparable soils in the Lefaga sequence. The soils of the Falealili sequence have a deeper solum, are less bouldery, have lower amounts of exchangeable bases, organic carbon, and total nitrogen, and contain larger amounts of gibbsite and free iron oxides than do comparable soils in the Lefaga sequence.

Soils sampled in the Papaloa sequence, formed on the oldest parent rock in Western Samoa, were originally collected to provide a rainfall sequence. Analysis of the soil data, however, shows that rainfall was not a major factor and that age only indirectly influences the formation of these soils. The important aspect of age is the degree of dissection of the landform. The soils of the Lefaga and Falealili sequence occur on the Mulifanua and Salani volcanics, which are relatively smooth and undissected compared to the rough, highly dissected Fagaloa volcanics.

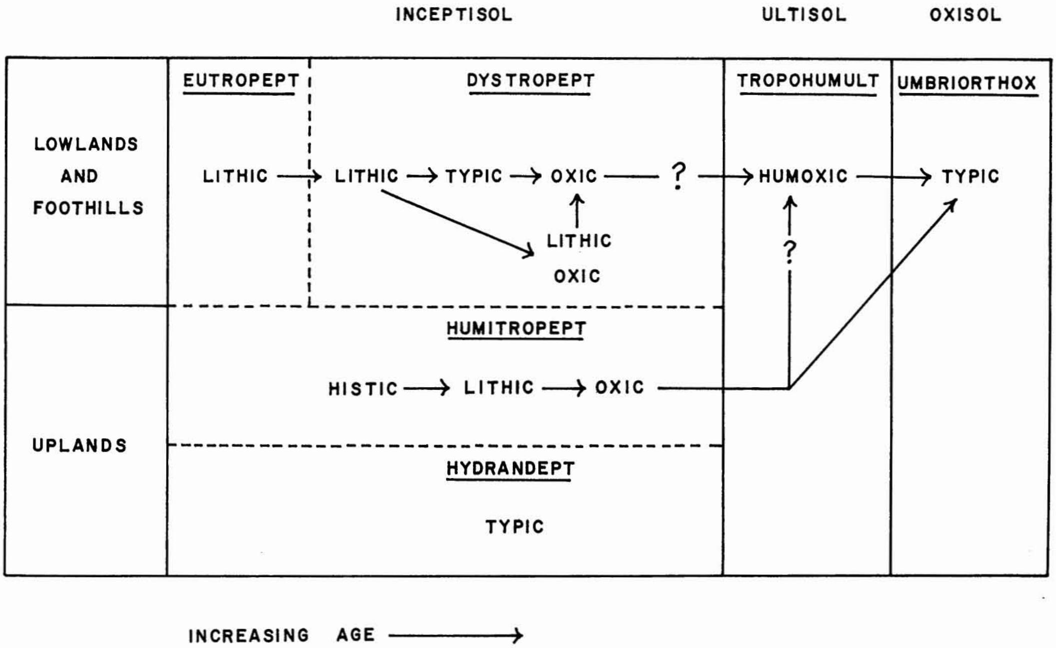

FIG. 2. Summary of the genesis of Western Samoa soils.

The Vaipouli series occurs on a level bench in Savai'i. Due to the long period of weathering, the base status is extremely low. The soil contains large quantities of gibbsite and free iron oxides, lacks weatherable minerals, and has a deep solum with a dense subsoil. All these properties are indicative of highly weathered soils called Oxisols. The Sauaga series, sampled on the steep slopes of the Fagaloa volcanics in southwestern Upolu, is shallow, low in bases, contains significant amounts of kaolin minerals, and has less gibbsite and free iron oxides than the Vaipouli series.

The Upolu series is less susceptible to erosion than the Sauaga series and more susceptible to erosion than the Vaipouli series. In mineralogical, chemical, and morphological development, the Upolu series lies between the Sauaga and Vaipouli series.

Correlation between Genesis and Classification

Different ages of parent rock and various climatic zones of the soils of Western Samoa offer an excellent opportunity to relate soil genesis to classification. Fig. 2 contains a summary of the genesis of the soils located in the lowlands, foothills, and uplands.

Soils of the lowlands are Lithic Eutropepts with a very high base content and a soil depth of less than 50 cm. Higher rainfall in the foothills causes leaching of bases and a decrease in base saturation. The resulting soils become Lithic Dystropepts or, with increased intensity of weathering, become Typic Dystropepts in which the solum is greater than 50 cm. With increasing age, both soils eventually become Oxic Dystropepts in which the CEC is less than 24 meq/100 g.

The young soils of the cooler uplands, classified as Histic Humitropepts, are rich in organic matter. With further weathering, the organic matter content decreases and the soils become Lithic and then Oxic Humitropepts. Soils developed on ash materials in the uplands are Typic Hydrandepts.

Finally, after lengthy weathering, the foothill and upland soils develop directly to Oxisols on relatively stable surfaces or to Ultisols on unstable surfaces.

SUMMARY

The age of parent rock and the amount and distribution of rainfall have the greatest in-

fluence on soil formation in Western Samoa. Soils derived on the youngest volcanic material show the weakest profile development. They have a shallow solum, are extremely bouldery, are higher in organic matter, CEC, and base saturation, and are lower in free iron oxides than those soils derived from the older volcanics. As the age of the soil increases, the mineralogy changes from mixed layer and amorphous materials to predominantly hydrated iron and aluminum oxides. Soils occurring on the steep eroded slopes of the oldest volcanics are halloysitic.

Soils experiencing pronounced dry periods in the lowest rainfall areas show weak mixed-layer mineral development. With increasing rainfall, amorphous materials, hydrated iron and aluminum oxides, and depth of solum increase, while base saturation and boulderiness decrease.

The soils, except for an Oxisol and a possible Ultisol, are Inceptisols. Dystropepts, Humitropepts, and Hydrandepts are the predominant Great Groups.

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